REMARKS

This application, as amended herein, contains claims 1-18 and newly add claims 19-22.

Claims 1-18 were rejected under 35 U.S.C. 112, second paragraph. The examiner is thanked for his helpful suggestions with respect to the claims. The claims have been carefully reviewed and it is believed that the deficiencies therein corrected by amendment herein. Accordingly, withdrawal of this rejection is respectfully requested.

Claims 1-7, 9-10, 12 and 15-18 were rejected under 35 U.S.C. 102(b) as anticipated by five different references. Claims 1-10, 12 and 15-18 were rejected under 35 U.S.C. 102(b) as anticipated by Blonder et al or Kalantar or Miyashita et al. Claims 11, 13 and 14 were rejected as obvious over a number of references. These rejections are respectfully traversed.

Applicants' invention, as set forth in claim 1, is directed to a light pipe for providing backlighting of a flat-panel display by means of at least one light source. The light pipe comprises a first surface, said surface including patterns having diffractive properties for coupling light out from the light pipe, said patterns comprising uniform, mutually different areas distributed on said first surface.

It is respectfully submitted that none of the prior art teaches or suggests a light pipe having patterns including diffractive properties for coupling light out of the light

pipe. As will be demonstrated below it is respectfully submitted that the statement in the office action that the prior art would perform equally well at diffracting light is simply incorrect. Diffraction is a phenomenon characterized by the diffracting body *size*. As discussed below the statement concerning the prior art having diffractive properties simply has no basis in fact.

All of the references describe techniques that utilize reflection and refraction as macroscopic phenomena applied on a relatively small scale. In addition, scattering in the references is provided by a diffuser or similar structure, that consequently to the placement of the scattering bodies, makes the scattering from such layers occur outside of the light pipe. Scattering in/from a diffusive material has different physics, but may be confused with diffraction as a consequence of the spelling of the word.

One advantage of the present invention is the saving of power by having the opaque diffusers of the prior art replaced by a diffractive structure of the light pipe, to obtain even distribution of the amount of light produced with just a small amount of power. A diffractive structured light pipe is not shown in any of the references. Instead the prior art is directed to diffuse lighting that wastes light power. These opaque structures in the diffusing bodies are covered extensively by the references. Thus, the references do not actually deal with diffractive optics at all in the sense of the invention or in any application related to invention, but rather reflections and diffusion of light.

In the macroscopic approaches in the references, reflectors and refractors act like mirrors in order to direct light. This differs from invention, wherein diffraction is achieved by microscopic formations that belong to the very same piece of light pipe, and are an integrated part on its surface. In the references the optical structures excluding the diffuser plates and like extensions are used in order to direct the light, whereas in the invention there is shown a way of producing a uniform backlight to a flat panel display by using diffraction. None of the references describe diffracting light pipe having grating like structure capable of diffracting light in order to produce a uniform backlight. Further, none of the references show, that the diffractive grating would be defined as depend locally on the position on first surface.

In summary, the references describe techniques that are old and based on reflection, refraction or diffusive light-wasting techniques that use a different acting phenomena than that of the present invention. The present invention provides a backlight with a light pipe having diffractive structure, without wasting diffusive materials whether it were in a form of resin or a plate. In the present invention the mechanism of light coupling out of the light pipe is ruled by different physics than in the references. The references, teaching away from the invention, at least partly explain how to avoid diffraction, and fail to describe a structure that uses diffraction for useful application as shown in invention.

With specific regard to the references Blonder et al. discloses in column 4, lines 47 to 67 a substrate, that

resides on a light pipe body. The substrate has been described as having microelements as frustroconical scatterers. Column 6, line 46 to line 54 describe how the substrate 220 surface should be smooth since additional scattering degrades the signal coming to the viewer. This is in stark contrast to the present invention in which the surface is grooved in a certain way to be diffractive and to produce uniform backlight. Therefore, the reference does not describe a diffractive light pipe, since the geometry of the structure as well as mechanism to couple the light out are very different. The structure described in this reference can be characterized as large reflectors of a macroscopic scale as scaled down, but to avoid diffraction. The smoothness of the surface described in column 6, from line 46 to 54 is approximately 0.5 −2.5 nm.

Kalantar et al. disclose their scatterers as huge; something in the order of a magnitude larger than described with respect to the present invention (column 3, line 30) with respect to the characterizing size parameter. Mathematical presentation of the techniques refers to reflection/refraction based macroscopic techniques in small scale, but not too small so that diffraction is avoided. Optical elements are mentioned as sized as 10-150 μm. Column 10 lines 5-51 says that the optical elements take about 1-20 percent of the total area, being more or less randomly scattered on the surface. However, in the present invention essentially the whole surface comprise the diffractive structure on the light pipe.

Ishikawa et al. ('549) describes the light source as linear, not point-like such as LED. The geometry between the light

emitting surface 1b and the ridges are differently set than in invention, but in addition the claimed light pipe is covered with diffusing material, so this reference belong to the category of diffusers, the diffuser being in a form of additional material outside the light pipe. In the present invention, the diffracting formations are of the very same material as the entire light pipe, and the out coupling mechanism of the light is different in the invention (Column 4, line 62 of the reference states that the diffusing or scattering material is filling). The geometry having a thinner end supports the fact, that the design is macroscopic and based on reflection and reflection in combination with diffuse lighting, and governed by different principles of physics than the present invention.

Yokoyama et al. ('497) mention diffuser plates and reflectors on the bottom of the light pipe. However, they do not describe diffractive light pipe that has a diffractive structure on its surface.

Yokoyama et al. ('556) shows a macroscopic light pipe structure with curved surface used in combination with light diffusing material.

Yoshikawa et al. uses a plate-plate structure (column 3, line 1, referenced to part 2) in combination with reflection. Thickness of the light pipe is said to be in the order of 1 mm, being quite large for the application of a flat display arrangement. Again, the present invention has the advantage of being able to eliminate the diffuser plate, which wastes precious power in a mobile device. Again, diffusion and

diffraction of light are different phenomena ruled by different laws in optics. Additionally, the manufacturing of light pipe in this reference may be somewhat troublesome compared to, for example, extrusion.

Ishikawa et al. seems to use a diffuser plate, referring to opaqueness of the structure, so the techniques used do not relate to a diffractive light pipe. However, the light pipe itself in this reference seems to be irrelevant, in that it is also based on refraction-reflection-diffuser techniques.

Miyashita et al. shows an air gap between the prism array and the light pipe (column 11, line 41). The gap may be there in order to produce a surface between two differently behaving optical material in order to produce total reflection. However, this reference does not describing a light pipe with a diffractive surface as in the invention. In column 15, on lines 17-28, it is stated that as a consequence of the wavelength of visible light, the quantities i and j in Figure 9 are of certain size (above 5 μm) in order to avoid interference of the light due to diffraction. Thus, the techniques in this reference belong to the reflection-refraction category in macroscopic scale optics applied to a small scale, but not so small as to cause diffraction.

It is noted, that in certain embodiments in this reference, (claims 14-20, for embodiments 7 and 8) diffraction is mentioned as a property of a direction changing means seperate and apart from the light pipe. However, this the only explicit reference to diffraction. It fails to describe a light pipe with diffraction properties as shown and claimed in claim 1.

In view of the above, it is respectfully submitted that claim 1 is directed to patentable subject matter.

Most of the remaining claims depend from claim 1. These claims recirte further limitations which, in combination with the limitations of claim 1, are not shown or suggested in thew art of record.

With specific reference to claim 5, which includes the embodiment of Fig. 10A, there is no teaching or suggestion of this structure in the references,

With specific reference to claim 6, there is no teaching or suggestion in the references to vary the fill ratio of a diffractive pattern in the prior art.

With specific reference to claims 13 and 14, there is no teaching or suggestion in the prior art of these specific dimensions to cause the diffraction in accordance with the invention.

Claim 17 has limitations analogous to those of claim 1. For the reasons set forth above with respect to claim 1, it is respectfully submitted that claim 17 is also directed to patentable subject matter.

Newly added claim 19 depends from claim 1 but specifies that the diffractive patterns have a geometry which is varied with position on said light pipe so that brightness of light is constant with position along said light pipe. Newly added

claim also 20 depends from claim 1 but specifies that the diffractive patterns have a fill factor which is varied with position on said light pipe so that brightness of light is constant with position along said light pipe. These limitations, in a light pipe having a surface with a diffractive pattern for coupling out light, are not taught or suggested by the art of record.

Claims 21 and 22 have limitations analogous to those of claims 19 and 20. It is submitted that these claims are patentable for the same reasons.

For all of the foregoing reasons, it is respectfully submitted that all of the claims now present in the application are clearly novel and patentable over the prior art of record. Accordingly, favorable reconsideration and allowance is respectfully requested. Should any unresolved issue remain, the Examiner is invited to call Applicant's Attorney at the telephone number indicated below.

Applicants petition for an extension of time of three months in which to respond to the office action. The Commissioner is hereby authorized to charge account #16-1350 in the amount of $926 for the required fee for this petition and for the presentation of two dependent claims in excess of twenty. Please charge any fee deficiencies associated with the filing of this paper to the same deposit account. A duplicate of this page is enclosed.

Respectfully submitted,

David Aker — AUGUST 1, 2001

David Aker (Reg. No. 29,277) — Date

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Marked Up Claim(s)

1. (Amended) A light pipe for providing backlighting of a flat-panel display by means of at least one light source, [wherein] comprising:

[- the light pipe is limited by a certain] a first surface, [-]said surface [comprises] including patterns [-said patterns have] having diffractive properties for coupling [the] light out from the light pipe, [-] said patterns [comprise] comprising uniform, mutually different areas [with a certain distribution] distributed on said first surface.

2. (Amended) A light pipe according to Claim 1 wherein

[-] said patterns comprise parallel [, straight or bowed,] elongated surface formations, the height and width of which differ from the environment,

[-] said patterns comprise a [certain] first uniform area, in which a [certain] characteristic parameter has a [certain] first value;

[-] said patterns comprise a [certain] second uniform area, in which said characteristic parameter has a [certain] second value, which differs from said first value;

and the surface formations in said first area differ from the surface formations in said second area with regard to said characteristic parameter, and said characteristic parameter is

at least one of the following: [the] orientation of the pattern, [the] distance between the pattern and the light source, [the -] period length, [–] fill factor, [-] fill ratio, [-] height, [-] characteristic degree of modification, [-] angle of deflection between the elongated surface formations of the pattern [, which differ from the environment].

3. (Amended) A light pipe according to Claim 2, wherein the value of at least one characteristic parameter depends on [the quantity, which has been] a value defined in relation to the light source [, such as the distance from the light source].

4. (Amended) A light pipe according to Claim 2, wherein the elongated patterns of the surface formations change gradually from [the] first shapes at a [of the] first end of the pattern at a [the] light source side to [the] other shapes [of the] at an opposite side of said pattern at [the other] another end in a manner depending on a quantity, which is dependent on a relation to the light source [, such as distance].

5. (Amended) A light pipe according to Claim 2, wherein [the] a local plane in the area of [the] a pattern, which plane is determined by [the] peaks of the surface formations of the patterns, is at an angle in relation to a [level] plane determined by the first surface of the light pipe [at an angle, which depends on a quantity, which is dependent on the light source, such as distance].

6. (Amended) A light source according to Claim 2, wherein at least one of the patterns has a fill ratio, and the fill ratio increases when moving from the end at the side of the light source to the opposite end of the light pipe.

7. (Amended) A light source according to Claim 1, wherein [the] distribution of the patterns depends on a quantity, which is dependent on a relation to the light source [, such as distance].

8. (Amended) A light pipe according to Claim 1, wherein [its] said first surface is on [the] a side of the light pipe, which is closest to the display.

9. (Amended) A light pipe according to Claim 1, wherein [the] elongated shapes of [the] surface formations in the patterns are repeated [as similar] in a [certain] uniform area of the surface of the light pipe.

10. (Amended) A light source according to Claim 1, wherein at least one of the patterns has a fill ratio, the fill ratio increases along a [the] central line of the light pipe from an [the] end at the side of the light source to an [the] opposite end of the light pipe, and the pattern has elongated formations, which [differ from the environment,] are perpendicular to the central line.

11. (Amended) A light source according to Claim 1, wherein the pattern has a fill ratio [is] between 0.2 and 0.5.

12. (Amended) A light pipe according to Claim 1, wherein at least one of the patterns has a fill ratio, the fill ratio increases as measured along a straight line when moving away from the light source, and the pattern has elongated surface formations, which [differ from the environment,] are bowed [as defined by conic section geometry], whereby the midpoint defined by the dimensions of the light source is located essentially at a focal point characterizing the bow.

13. (Amended) A light pipe according to Claim 2, wherein at least one pattern has a [the period length of its diffractive surface in a] diffractive structure with a period length [is] between 1.5 and 3.5 µm.

14. (Amended) A light pipe according to Claim 1, wherein [the] depth and/or height of [the] elongated surface formations of [its diffractive] the surface [in a diffractive structure] is between 0.3 and 0.7 µm.

17. (Amended) A light pipe arrangement comprising:

[-] a light source,
[-] a display,
[-] a light pipe, and
[-] a base plate of the light pipe,

wherein

[-] the light pipe is limited by a [certain] first

surface, [-] said surface comprises patterns, [-] said patterns have diffractive properties for coupling the light out from the light pipe, [-] said patterns comprise uniform, mutually different areas with a [certain] distribution on said first surface.

18. A light pipe arrangement according to Claim 17, [wherein the number of light sources is] having three light sources.